Dynamics of the Northwest Australian Shelf and Slope

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LONG-TERM GOALS

We seek to understand shelf and shelf-edge phenomena associated with regional-scale currents, buoyancy forcing, wind forcing and mesoscale variability. We are most concerned about the dynamically active "contact zone" between coastal and oceanic waters and how it is affected by phenomena both offshore and onshore.

OBJECTIVES

The shelf offshore of northwestern Australia has been chosen for the area of concentration. This region is particularly interesting because of the important role played by buoyancy forcing (evaporation, hence cooling and salinization) over the shelf and because it is the believed to be the area in which the poleward-flowing shelf-edge Leeuwin Current forms (Holloway, 1995). An added level of interest is provided by the extremely high-amplitude M_2 tides that are found in this area (Holloway, 1984). An added level of interest is provided by the recent development of ideas on buoyancy arrest of bottom boundary layers (Trowbridge and Lentz, 1991) that invalidate the generally accepted ideas about dynamical balances within the Leeuwin Current (Thompson, 1987).
We thus seek to carry out both observations and dynamically motivated numerical modeling activities that will lead to a new understanding of 1) mesoscale variability associated with the shelf-edge Leeuwin Current, 2) how evaporative forcing affects variability and water mass composition, and 3) the dynamical balances in the Leeuwin Current itself.

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14. ABSTRACT
We seek to understand shelf and shelf-edge phenomena associated with regional-scale currents, buoyancy forcing, wind forcing and mesoscale variability. We are most concerned about the dynamically active ???contact zone??? between coastal and oceanic waters and how it is affected by phenomena both offshore and onshore.

15. SUBJECT TERMS

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APPROACH

In-situ observations (Brink and Shearman), including currents, temperature and salinity, are used to characterize shelf and slope conditions during the austral winter (dry season) northwest of Australia. High resolution in both space and time are required in order to fully characterize structures in terms including time variability and spatial scales. The observations, along with historical information are then used to motivate dynamically driven numerical modeling studies (Chapman) that will elucidate processes and put them into a more global context of ocean processes.

WORK COMPLETED

During 2003, our focus changed from the coast of Vietnam to waters north of Australia. Prior to this point, we made considerable efforts to build ties with Vietnamese oceanographers. During 2003, we redirected towards new region, defined objectives, obtained permissions and arranged for ship usage. A 29-day cruise (Port Hedland to Darwin) then took place during June and July 2003 (roughly over 118-122º E, 15-20º S). An ADCP mooring was deployed for 26 days near the 150m isobath north of Port Hedland, and an intensive 3-line CTD survey was carried out in order to establish regional scale structures. A regional scale SeaSoar survey (0-200m depth, or to within 10m of the bottom) was then carried out, followed by repeated mesoscale surveys near the mooring. Finally, Minibat surveys of temperature and salinity were made in shallower shelf waters in order to characterize the energetic small-scale (1-5 km) variability associated with surface cooling. Data processing and quality control are presently underway.

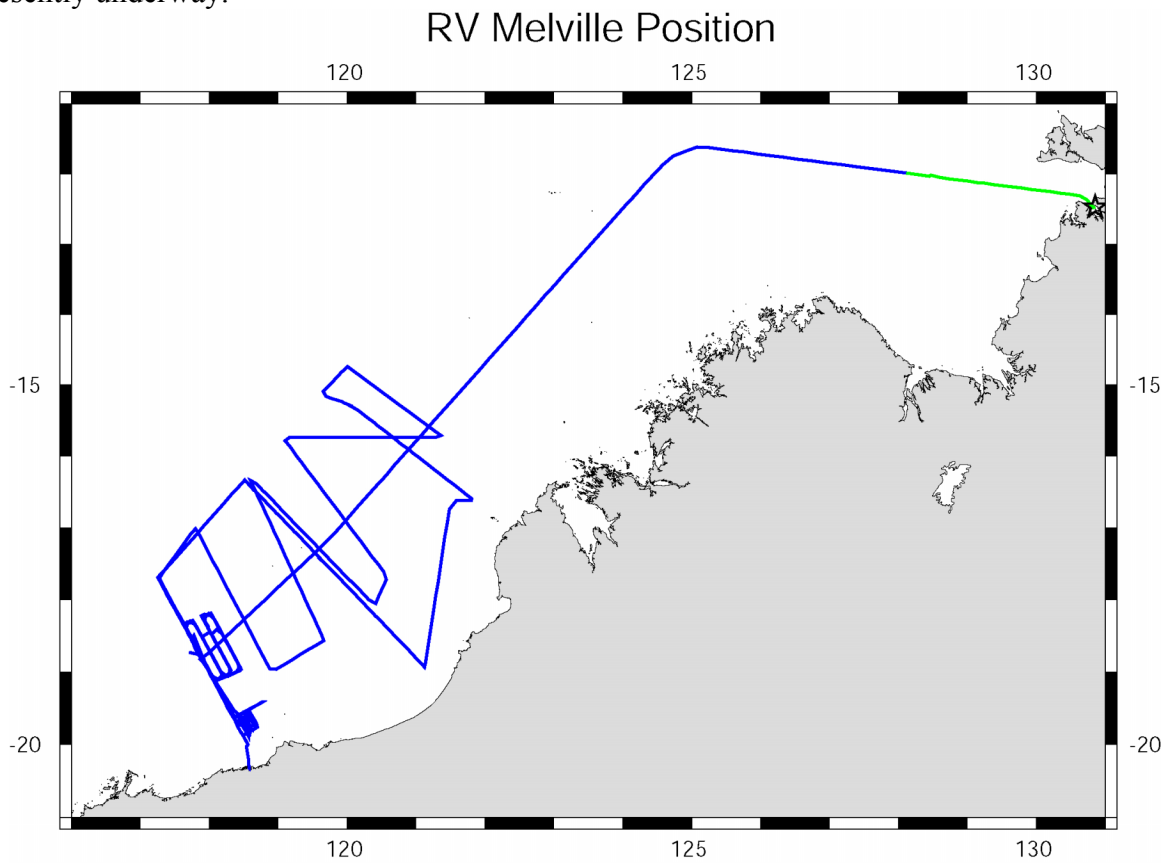

Figure 1: Sampling track of the June-July, 2003 R/V Melville cruise.

RESULTS

Waters at all depths were found to become increasingly salty towards the west, and a shelf edge jet, identified with the Leeuwin Current, was found as far east as 122º E. Consistent, but highly variable, tongues of salty shelf water were often found spreading offshore at the shelfbreak (figure 2). We had not anticipated that the Leeuwin Current would be found so far north, and in such a developed state. It is thus conceivable that the Leeuwin Current core may be associated with the Indonesian throughflow. The finding that water becomes saltier toward the west suggests that salty water formed over the shelf can spread efficiently offshore. These results, as yet, are highly tentative but do indicate that the phenomenology found is much richer than we may have expected.

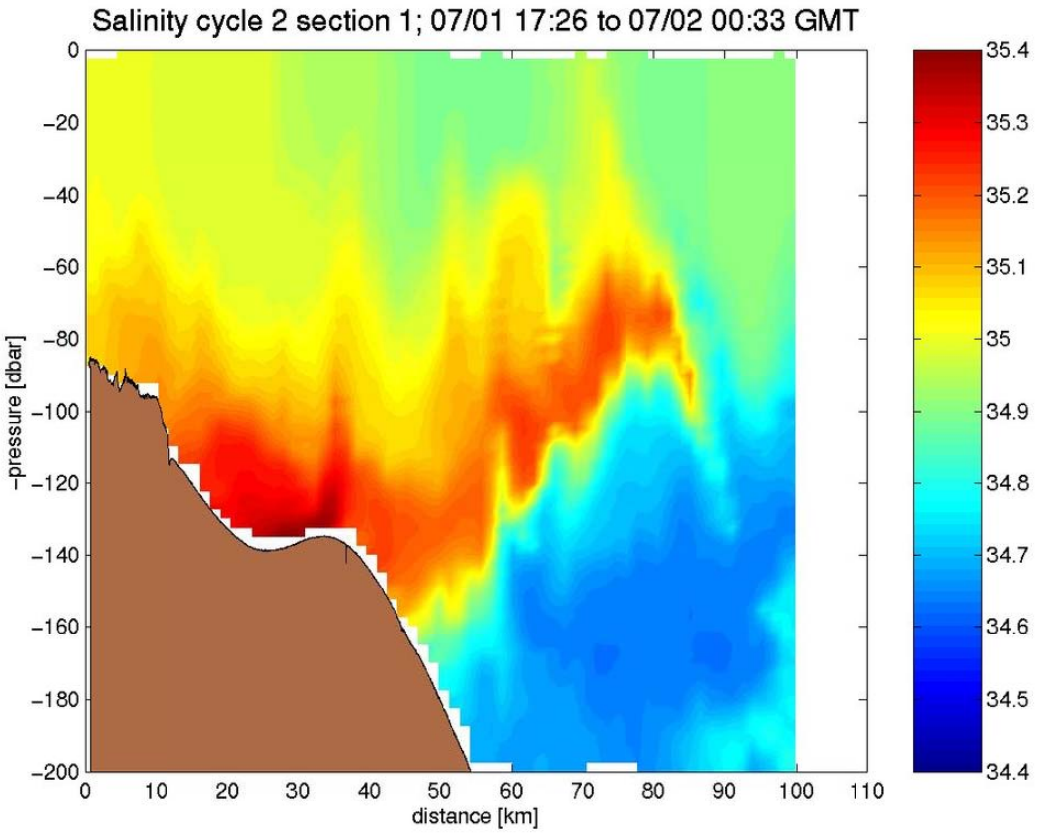

Figure 2: Representative SeaSoar salinity section across the shelf edge in the western part of the sampling domain. Note the short-scale variability associated with internal tides and the tongue of salty shelf water protruding offshore.

IMPACT/APPLICATIONS

We expect that our results regarding evaporative forcing will be applicable to a number of continental shelves adjoining desert regions, such as off the Arabian peninsula. Our results with regard to shelf edge instability processes are expected to be applicable (or at least comparable) to a number of regions

with broad shelves and shelf-edge currents such as the Mid-Atlantic Bight. Our anticipated findings with regard to dynamical balances associated with the Leeuwin Current should be applicable to a range of mean-flow issues over all continental shelves.

TRANSITIONS

None

RELATED PROJECTS

This work should supplement the NSF-sponsored INSTANT program that studies the Indonesian throughflows (Dr. A. Gordon, LDEO, contact). Dr. Paula Coble's (USF) group participated in our cruise, studying colored dissolved organic material.

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PUBLICATIONS

None to date

PATENTS

None